LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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The Art of Purchasing Lubrication

IN THE development of industrial progress, lubrication has been an outstanding factor. In fact, it is justifiable to state that present day civilization depends on a film of oil.

We need but to call upon our imagination to appreciate the significance of this. We have but to picture the conditions, if we can, should the supply of petroleum lubricants suddenly fail for any reason.

What would happen to modern methods of transportation? Would not our steam and electric systems come to a standstill? Would not our motor cars, airplanes, steam and motorships be useless without petroleum lubricants?

What would happen to our vast manufacturing and electric generating plants? Would they not stand idle and rust away without petroleum lubricants, leaving our cities in virtual darkness, for example?

And our skyscrapers? Is it not true that the elevator has made them possible, and can the elevator function without lubrication?

In addition, what percentage of the population of our large cities would survive the famine and pestilence that would inevitably follow the complete breakdown of our transportation and communication systems? Food and fuel would cease to come in; the water supply would cease to function. The sewage systems could not be operated.

Imagine, furthermore, to what extent crime would add its toll to the general misery, in all this chaos and in the absence of electricity and gas for lighting purposes, and communication by telephone, telegraph or radio.

Under such conditions, the only method of thought communication would be by word of mouth or by post horse. In turn, with the stoppage of our transportation systems, the only method of travel would be by foot or on horse-back, and the only method of transporting commodities would be by pack-horse, on horse drawn vehicles or on man's own back.

It would be practically impossible for the world to produce enough animal and vegetable oils, at a reasonable price, to continue the present mechanical structure in a state of operation, to say nothing of providing a surplus for development and growth.

In short, should the world's supply of petroleum lubricants suddenly cease, complete chaos would inevitably result, with the development of another "Dark Age" to set back civilization to the primitive era.

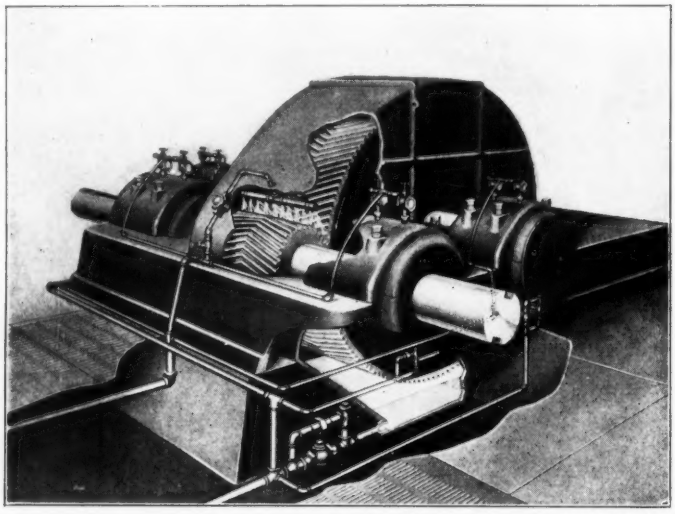
The main difference between man of today and his forebears in previous stages of advanced civilization is his ability slowly acquired through the ages, and bursting into full bloom with the advent of petroleum, to quickly communicate his thoughts to people in distant places and to transport himself and his commodities quickly from place to place. All of this ability, so slowly and painfully acquired, would be rendered helpless and the industry of the world would come to a standstill if the supply of petroleum lubricants were suddenly cut off.

These contrasts help us to realize the great fact that petroleum is the basis of the mechanical age in which we are living, and which has developed during the last three-quarters of a century.

THE EFFECT OF LUBRICATION ON POWER CONSUMPTION

Granting all this to be true, let us, in turn, consider the factor of power consumption. In

the operation and maintenance of any piece of machinery power consumption must be taken more and more into account today. For the cost of power is ever increasing, gradually, to be sure, but nevertheless increasing. There are varied reasons for this; for example, the cost of labor, the cost of raw materials, and increased requirements due to installation of added equipment year by year in virtually every power or industrial center.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 1—Circulating lubrication as applied to a set of encased herringbone gears. Oil is delivered to point of mesh of the gears. Note piping details. Flood lubrication in this manner should effectively flush foreign or abrasive matter from the system.

This is a natural course of events in any civilized community subject to the normal expansion in population, and the natural desire to improve living conditions and add to their comforts.

It is, of course, however, reflected in the price which must be paid for these comforts or necessities in order that civilization may exist and continue to advance.

Price reduction has been a popular topic ever since the late War. It has been the slogan of the uplifter, and the bait of the efficiency expert. As a rule, however, it is viewed from a superficial angle only. Production schedules are revised, re-routing of materials put into effect, handling methods improved, and the power plant studied in detail to increase the amount of steam or electricity developed per unit volume of fuel consumed.

But too many are prone to stop at this point. The larger items, such as the coal pile, the fuel oil storage tank, and the volume of the finished product are too dazzling. They overlook or disregard the operating efficiency of the respective machinery involved, the extent to which certain equipment may be taking too much power for its quota of production, and the manner in which its operation should be improved.

This latter is directly a matter of friction reduction by application of more effective lubrication. In fact, friction will frequently have more bearing upon the productive or power transmission efficiency of a machine than anything else involved in its operation. And yet, because it is an invisible force acting in many instances, on enclosed parts, it will be overlooked.

Perhaps this is a natural consequence, for power consumption tests are vague to the average operator, they must be carefully made, and very frequently those who may have to do with efficiency problems have not the time or patience to carry them out to completion, even though they will normally involve but a measurement of unit power input per unit of production output. As the former is decreased with due maintenance of speed and production we may logically assume that reductions in friction between the various wearing elements are largely responsible for such improved operation, provided, of course, that steam or electric power is handled and applied in an effective manner.

THEORY AND PRINCIPLE OF LUBRICATION

Inasmuch as effective lubrication should be the ultimate recourse wherever abnormal friction may prevail, a clear understanding of its meaning will be necessary.

Essentially it means the reduction of solid-friction or metal-to-metal contact between any two moving elements, in such a manner as to result in the minimum of wear or loss of power in the maintenance of motion or operation.

This is brought about by the use of a lubricant which will be capable of maintaining a protective film between the wearing surfaces. This film must, of course, be of fluid nature in order that it may readily penetrate throughout all clearance spaces. So, even though the original lubricant may be comparatively solid, as in the case of a grease, the ultimate film must be fluid.

By means of this film solid friction is supplanted by fluid friction. In other words, those microscopically high spots which exist on practically any metallic surface, regardless of its polish or machining, are prevented from coming in contact with each other.

If there is adequate fluidity within the

lubricating film to facilitate ready conformation to the motion between the solid surfaces involved, a minimum of fluid friction should be developed. In other words, the film should most effectively serve its dual purpose in:

1. The elimination of metallic wear and
2. The prevention of abnormal temperature rise.

The degree of success attained will depend upon the relative fluidity or viscosity of the oil which constitutes the lubricating film. A lubricant does not just lay in the clearance space and allow the moving part to slide over it, much as a sled runner would pass over smooth ice. Instead its component particles are in constant motion with respect to each other and to the metallic surfaces involved. If these particles move sluggishly, that is, if the viscosity is too high in accordance with the operating speed and pressure involved, they will tend to develop abnormal friction within the film itself. This will be indicated by rise in bearing temperatures and increase in power consumption.

In other words, the purpose of lubrication will be more or less defeated.

The Lubricating Film Illustrated

An idealistic picture of an oil film (Fig. 2) would show:

A—As the upper part, and
B—As the lower part,
C—Being the upper metallic surface, and
D—The lower metallic surface.

The distance between C and D is called the clearance.

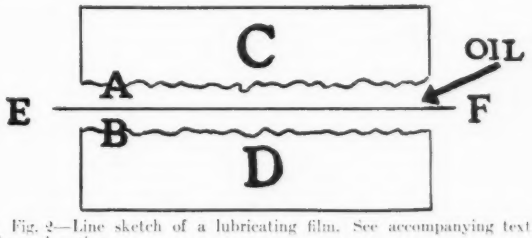


Fig. 2—Line sketch of a lubricating film. See accompanying text for explanation.

Assuming that the oil film is divided into two parts along the line E F. Oil layer A fills up the slight crevices of the metal surface above it and sticks to that metal surface.

Oil layer B does the same for metal surface D.

Now, if the upper metallic surface is moved to the right, the oil-layer, which is in direct contact with it, will move along with it and slide with it over oil-layer B.

There will then be two smooth surfaces (of oil), one sliding over the other, instead of two comparatively rough surfaces of metal sliding over each other. Motion will be accomplished easily and there will be no metal-to-metal contact. In other words, no solid friction.

But actually the oil will not be split into two layers with a clean break between them.

It is believed by some to be split into many, many layers, somewhat like a deck of cards, with some resistance between each layer, and more resistance due to the molecules of the oil moving from one layer into another.

And when there is any resistance to motion, heat is generated and the faster the motion, the greater the heat.

FACTORS INVOLVED IN PURCHASE OF LUBRICANTS

An insight into the factors involved in the attainment of effective lubrication will be of decided interest in this regard. To enable mutual understanding they are very frequently termed specifications; or better still, characteristics, inasmuch as they refer to tests which are indicative of the physical nature of any lubricant and the chemical make-up in certain cases.

It is gratifying to note that more and more are prospective users of lubricating oils and greases coming to a realization of the fact that operating conditions should be given the utmost consideration in the selection of such products.

Price buying or the use of more or less stilted specifications have been recognized by the thoughtful executive as decidedly unsatisfactory in many cases. Not that lubricants bought by price alone or in accordance with certain specifications may not frequently give quite satisfactory service; if they are the products of a reputable manufacturer in the Petroleum Industry his judgment in offering them should usually be an assurance of their adaptability.

The Manufacturer Must Be Dependable

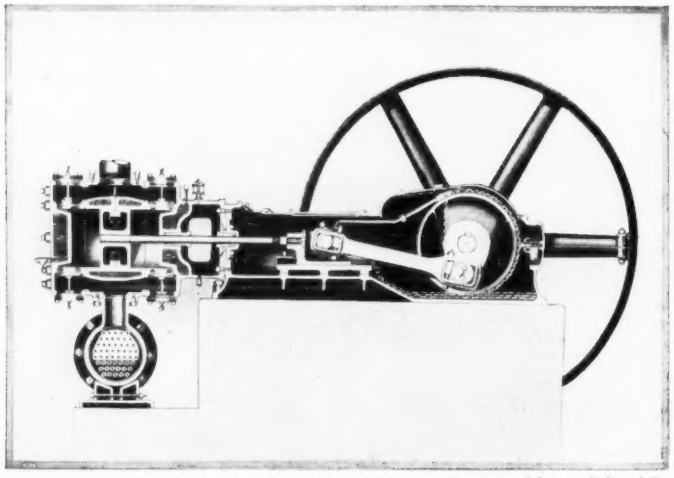
But all manufacturers are not absolutely dependable. Nor have they the technical ability to judge what to offer when up against price competition or a hard and fast set of specifications. Frequently the sole idea will be to undersell their competitors; whether or not the products applied will ultimately serve the intended purpose is too often overlooked.

Even if trouble does occur. What of it? In many plants it is so easy to blame the operator, the means of lubrication, or the construction of the machinery involved.

Such conditions are the bane of the reputable lubricating engineer. He is so frequently judged by the actions of his more unscrupulous competitors.

Where Specifications Count

And yet, specifications must not be entirely overlooked. Frequently certain of them will be of decided importance. Take the matter of pour test, where a lubricant is to be used under abnormally cold conditions; or the carbon residue content, when high temperatures may be involved. Price buying here might be absolutely ruinous to costly machinery and entail all manner of expense due to time lost, necessity for repair and cessation of production.



Courtesy of Ingersoll-Rand Co.

Fig. 3—Sectional view of an air compressor showing in particular the circulating oiling system for the so-called external bearings. Air compressor cylinder oils must be of low carbon residue content.

In view of the fact that improvements in the processes of producing, refining and compounding may frequently tend to require revision of the so-called standard methods of test, the question of their up-to-dateness will also be of importance.

In other words, they must have value in exacting the proper limitations from the manufacturer of petroleum products, otherwise they may simply be mere arbitrary limitations imposed on his products by virtue of precedent.

In the oil industry the tests which are carried from the refiner to the consumer represent the methods in vogue at the refinery for securing uniformity in manufacture. Here they are useful in comparing lubricants made from the same crudes or a mixture of crudes.

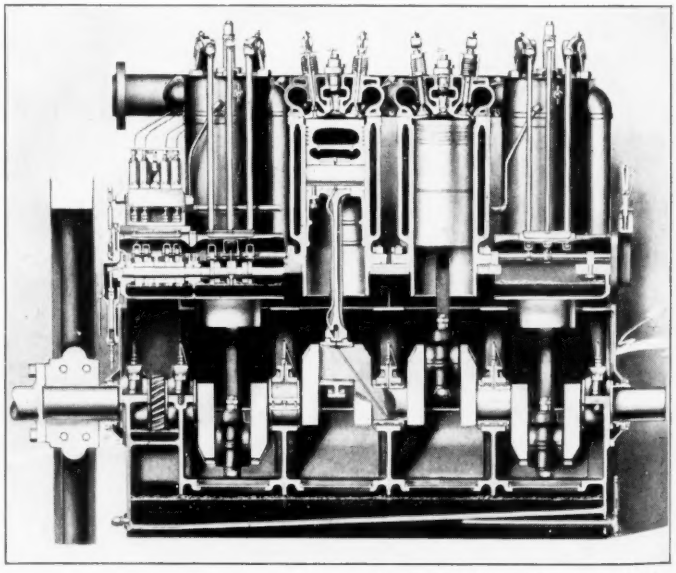
The Comparative Value

Years ago, when the oil business used to be confined to a comparatively small section of the country and practically every refiner worked the same variety of crude oil, specifications based on such tests had a comparative value. Just as, in fact, they have today where oils of similar base or blend are involved.

The spread of production, however, over a very much wider area and into fields from which crudes of marked difference in physical characteristics are obtained, naturally has reduced the value of such comparative tests. Chemical and physical characteristics of the crudes in question will vary too widely. So while it may be perfectly practicable to make these tests, the value of certain of them as a means of indicating the suitability of any particular product for a specific purpose may be indeterminate.

Operating Conditions Rule

This will, of course, be particularly true in the case of lubricating oils where conditions of operation may vary from the most delicate machinery where very exact motion and production are required, to the heavier duty units involving high pressures, frequently wide variations in temperature and exposure to dust, dirt or to the elements.



Courtesy of Chicago Pneumatic Tool Co.

Fig. 4—A four cylinder oil engine in detail. Lubricating oils for such equipment must be highly refined, of low carbon residue content and of adequate viscosity to meet cylinder operating temperatures.

Inasmuch as viscosity will have a bearing upon the extent to which a lubricating oil will withstand such operating pressures, just as pour test as already stated, for example, will

indicate its ability to function at low temperatures, it is deemed advisable to discuss in detail the more customary tests referred to above. In this way we can bring out the true meaning of each and its real value as a means of determining the nature and suitability of any lubricating oil whether this latter is involved as a specific product or as a component of a grease.

THE TESTS INVOLVED

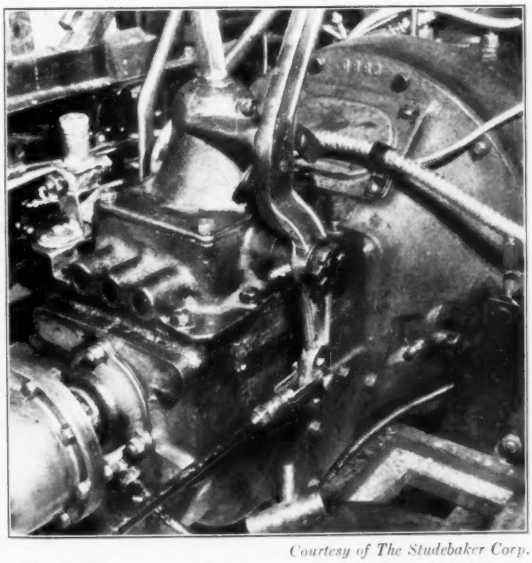
By many, these tests are referred to as specifications. More correctly, however, they should be regarded as characteristics, since they will be indicative of the base of the product, the source of the crude from which it has been obtained, its physical properties, and the extent to which it may meet the operating conditions involved.

The more outstanding characteristics which should be understood with respect to subsequent operation, and which may be a necessary part of specifications for lubricating oils for certain classes of work will be:

The Viscosity,
The Pour Test,
The Flash and Fire Points, and
The Carbon Residue Content.

Viscosity—an Indication of Fluidity

Knowledge of the viscosity or relative fluidity is frequently of decided value as a guide to the ability of an oil to meet operating



Courtesy of The Studebaker Corp.

Fig. 5—The emergency brake connections of a motor bus. Pressure grease lubrication is employed for such parts.

temperatures, or to flow as desired through the lubricating equipment. Inasmuch as this term may be vague to the layman or one not conversant with the manufacture of petroleum products, brief repetition of what it really indicates will be advisable.

As a matter of fact, it should be more correctly noted as the operating viscosity or the

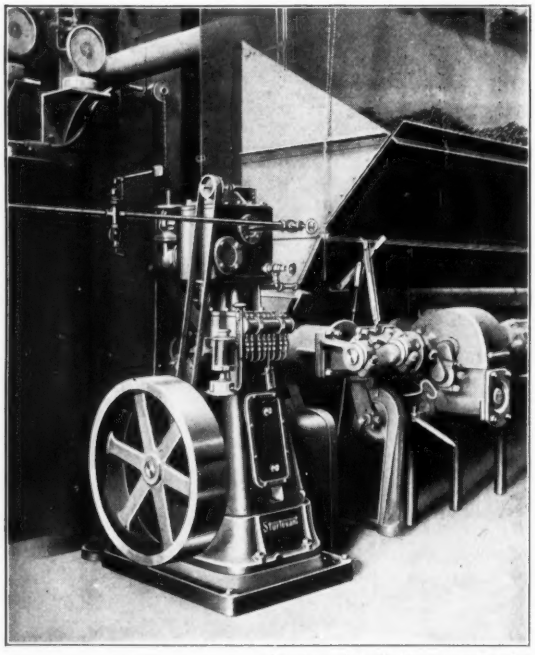
Courtesy of Industrial Works.

Fig. 6—Under view of a tractor element showing exposed nature of the gears and track connections. In the operation of such equipment requirements of lubrication may vary widely due to dirt, water and temperature conditions. Obviously no definite specification can be laid down for the lubricants for such machinery, it will all depend on operating conditions.

fluidity at the temperatures of operation, rather than at certain arbitrary test temperatures such as 100° or 210° F. For there is a direct tie-up between power consumption, friction and temperature. If an oil is too heavy or viscous it will impose more or less drag, resulting not only in added power consumption, but also in probably higher bearing temperatures due to internal friction. Conversely, if the viscosity is too low, or in other words if it is too fluid for the bearing pressures involved, solid or metallic friction may occur, likewise to show up in the power bill, as well as in the cost of repair or replacement of prematurely worn bearing surfaces.

Viscosity is indicative of the relative fluidity of an oil at the temperature of test. Therefore, when an oil is quoted as having a viscosity of, let us say, 500 seconds Saybolt at 100° F., this will mean that at a uniform temperature of 100° F. it will take 60 cubic centimeters of the oil in question 500 seconds to flow through the orifice of the standard Saybolt viscosimeter. Viscosity is possessed by all oils in varying degrees.

It can be appreciated that the statement that a certain oil has a viscosity as above may be meaningless to many unless they are able to contrast the fluidity involved with that of some product with which they are more intimately



Courtesy of B. F. Sturtevant Co., Inc.

Fig. 7—A mechanical stoker with its driving engine. Frequently comparatively high operating temperatures will influence the selection of suitable lubricants to a marked degree.

familiar. It is for this reason that 500 seconds has been chosen for the above example, for it is approximately the viscosity of the average heavy automobile motor oil with which practically everybody is familiar.

The value of viscosity as a specification or characteristic, to one who is intimately conversant with its meaning, will be as a guide to the ability of any particular oil to meet his prevailing operating pressure and temperature requirements. He should have studied or developed these for all machinery involved, by comparative testing of lubricants of varying viscosity. He can then judiciously dictate viscosity as a specification, or judge it as a characteristic when quoted by his oil man.

Value of Pour Test

Wherever cold operation may be involved the pour test of a lubricating oil will be a very important characteristic, and should always be investigated by the purchaser. Broadly, the pour test will be indicative of the ability of an oil to function properly at low temperatures. Usually it is the lowest temperature at which the oil will pour or flow.

The pour test, being a temperature measurement, can be more easily understood by the layman than the viscosity, for example. From a comparative viewpoint, it will generally be of decided interest as a guide to the base of petroleum lubricants.

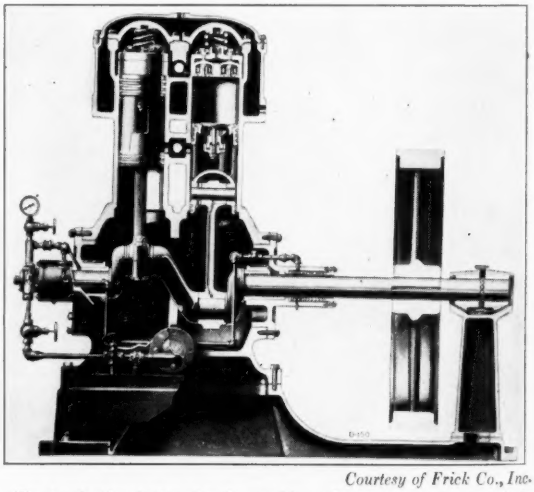
As a general rule, oils of naphthenic base will show a lower pour test than those of paraffine base. In the latter, unless careful treatment has been given, a certain amount of wax will be present which will promote earlier congealment as the temperature is reduced. With many of such products the pour test will frequently be appreciably above 30° F.

Where such temperatures may represent average operating conditions it is evident that the most careful attention must be given to insure selection of oils of adequate fluidity. From a practical point of view the pour test may even be regarded as representing the lower operating limit, especially with oils which must flow of their own accord by virtue of the means of lubrication provided.

This will be especially true where drip cup or splash lubricating systems are involved. Here the amount of oil which will be delivered to the wearing parts will depend to a great extent upon the fluidity. As a result any tendency towards congealment or sluggish flow in event of low operating temperatures may result in impaired lubrication with the other evils attendant thereto.

Flash Point an Indication of Base

Another characteristic in petroleum lubricants which may be indicative of the base



Courtesy of Frick Co., Inc.

Fig. 8—Sectional view of an ice machine. The pour test characteristic must always be considered when selecting compressor oils. Furthermore, they should be of comparatively low to medium viscosity to insure adequate fluidity.

or nature of the parent crude is the flash point.

In general the flash point should only be regarded as of value in event of possible usage of the lubricant in question under abnormally

high operating temperatures or where exposure to open flame, steam or electric heating mediums may be involved. Instances of this would include the lubrication of open-hearth charging equipment in the steel industry, operation of glass moulding machinery, lubrication of the automatic baking oven, or steam cylinders functioning on superheated steam.

Where lubricants are exposed to direct heat abnormal vaporization of the more volatile constituents may occur. The result will be accumulations of non-lubricating carbon residues. If allowed to occur with any regularity oiling grooves or lubricating equipment may become seriously clogged, to reduce the flow of lubricant to the wearing elements and frequently lead to abnormal wear or even burning out of bearings.

Generally speaking, the flash point is that temperature at which an oil will commence to give off an appreciable amount of surface vapor which will tend to form an inflammable mixture with air. Flash point in a petroleum lubricant is measured by gradually raising the temperature until the vaporous mixture given off will ignite momentarily upon the application of a flame. The temperature of the oil at which this occurs is noted as its flash point. It is an arbitrary test and requires specification of the type of apparatus used, if it is to be of any value at all.

Flash Point Precedes the Fire Point

Continual and gradual raising of the temperature of an oil in the flash testing apparatus will ultimately result in the development of a sufficient volume of inflammable vapor as to cause actual ignition and burning to occur. When this latter continues for at least five seconds, the temperature of the oil should be noted as the fire point.

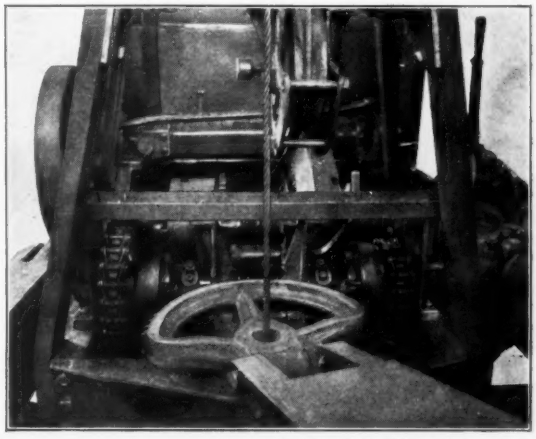
All such heating, of course, must be carried out in a room or compartment which is free from air drafts. Even breathing over the apparatus may materially affect the formation and ignition of vapors.

Flash and fire points are chiefly of value as an indication of the relative initial volatility and temperature-resisting ability of any lubricating oil. They are not definite temperatures at which boiling takes place, or at which the products may pass completely over to the vapor stage. Normally higher flash and fire points for oils of the same hydro-carbon make-up will accompany higher viscosity. This must be considered where oils for high temperature lubrication are involved.

Carbon Residue Often Objectionable

For certain classes of operation the carbon residue content of a lubricating oil may be regarded as the most important characteristic involved, and one which should be given careful study when planning a specification.

Wherever high temperature lubrication is involved, there will very frequently be a possibility of development of carbonaceous de-



Courtesy of Austin Machinery Corp.

Fig. 9—Where wire-rope, gears or chains operate exposed, adhesiveness is an important characteristic in their lubricants in order that the effects of centrifugal force may be withstood.

posits as a result of breaking down or partial decomposition of a lubricating oil when it is heated to approximately the temperature of distillation.

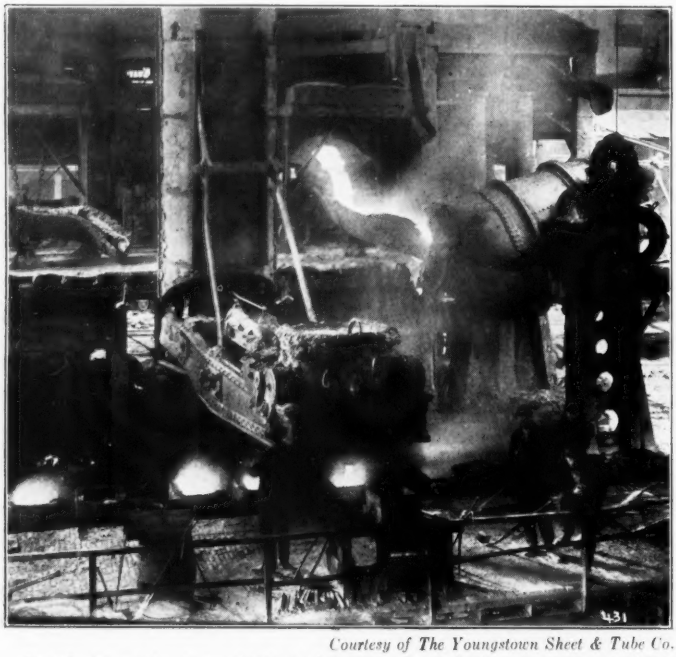
This will, of course, depend upon the extent of refinement of the oil, its initial viscosity, the base of the crude from which it has been made, and the degree of heat involved. It is safe to state, however, that all mineral oils will ultimately carbonize or distill down to a residue of carbonaceous matter if subjected to sufficient heating for any length of time.

And yet, from particular types of crudes, distillates can be made which will show an almost negligible amount of carbon. For example, a paraffine base steam cylinder oil of comparatively high viscosity will distill to a considerablygreater residue than a naphthenic base distillate such as a medium viscosity motor oil. As a result, where it is necessary to use residual oils either alone or as a component of blended lubricants, the potential carbon residue must be given careful consideration. It will, however, depend upon the degree of refinement of the residual product, as stated, and upon the amount used.

Importance Dependent Upon Type of Service

The extent to which this may be an ultimate detriment will naturally depend upon the use to which the lubricant is to be put. In an anti-friction bearing, for example, carbonaceous deposits due to abnormal vaporization of an oil under higher temperatures might seriously impair effective rolling between the balls or rollers and their respective raceways or cages.

A set of exposed gears adjacent to a Bessemer converter, however, would function effectively irrespective of the carbon content of the lubricant, provided that this latter possessed adequate body or viscosity to prevent actual metal-to-metal contact between the gear teeth at the temperature of operation.



Courtesy of The Youngstown Sheet & Tube Co.

Fig. 10—In certain phases of industrial plant operation the duty imposed upon lubricants will be decidedly severe. This will hold true for ingot car wheel bearings and converter mechanisms when pouring hot metal, as above.

In the Internal Combustion Engine

The internal combustion engine of the Diesel or semi-diesel type is a most interesting case where lubrication of cylinders, especially, must be effected under comparatively high operating temperatures, and furthermore, where carbon residues may be of serious consequence.

Broadly speaking, carbon can never be eliminated. It is an essential element in any petroleum fuel or lubricating oil, and, therefore, must pass through every engine. It is only a detriment, however, in the form of soot, or deposits of carbonaceous tarry matter. In chemical combination with hydrogen and oxygen it is a basic requirement, and a factor in the occurrence of combustion.

The use of too much lubricating oil will tend to promote accumulation of carbon, especially where there is possibility of the excess oil being burned to free carbon.

In the two-cycle engine, wherever incomplete combustion occurs and too much cylinder lubricating oil is fed, the resultant carbon deposits will be particularly detrimental where they accumulate around, and tend to clog up the exhaust ports.

Incomplete combustion is the forerunner of such a condition, the resultant soot tending to dry up a normal lubricating film on the cylinder walls. The indications of this will be similar to the actions of the engine when overloaded, i.e., piston drag due to excessive friction causing smoke, knocking and laborious operation.

Air Compressors Also Affected

Likewise in air compressor operation will it be necessary to pay careful attention to the carbon residue specification. Continued operation on any oil which may tend to develop an abnormal amount of carbon may ultimately result in decidedly objectionable deposits, in the receiver or air lines. Such deposits will be increased if an appreciable amount of dust or dirt is carried in by the air and if the lubricating oil is of such nature as to distill to gummy residues.

Investigation, Therefore, Always Advisable

As a result, it will always be advisable to investigate in detail the carbon residue content of such lubricants as are to be used for lubrication of intricately designed mechanisms, especially under high temperature operating conditions.

In this category would also be included lubricants for electric motor bearings, or, in fact, for service anywhere in the boiler or engine room, cement plant, paper trade, steel mill, textile or metallurgical industry, etc., where heat treating of products or the generation or application of steam may be involved.

ACTUAL SERVICE REQUIREMENTS

And yet, even with detailed knowledge of the theory and principles of lubrication, and the bearing which certain characteristics as outlined above may have on the subsequent performance of any lubricating oil, our ability to judge the suitability of such a product will be handicapped unless the basic requirements are understood. As a result these are noted below, viz.:

1. The oil should possess sufficient body to keep the bearing surfaces apart at the temperature at which these bearings run.
2. It should possess such qualities as will reduce the friction to a minimum.

3. The flash point should be sufficiently high to insure against the presence of too volatile constituents.
4. It should remain fluid at such low temperatures as will be met in service conditions.
5. It should have no tendency to decompose or to form such deposits as will gum up the machine and increase the friction where the object is to decrease it, and
6. It should contain no ingredients which will corrode, score, rust or pit the metallic surfaces of bearings, shafting, gear teeth, or other wearing elements.

THE LUBRICATING ENGINEER

In view of the fact that the average purchasing executive will be comparatively unfamiliar with the operating conditions in his plant, and the duty which will be required of lubricants, he should always take the lubricating engineer into consultation. In fact, purchase of lubricants should be the subject of conference wherever there may be operating problems or intricate machinery involved.

The lubricating engineer should be a specialist in the selection, handling and application of lubricants. He should have an intimate knowledge of the principles of refining and compounding of lubricants for specific purposes, and complete familiarity with systems and means of lubrication.

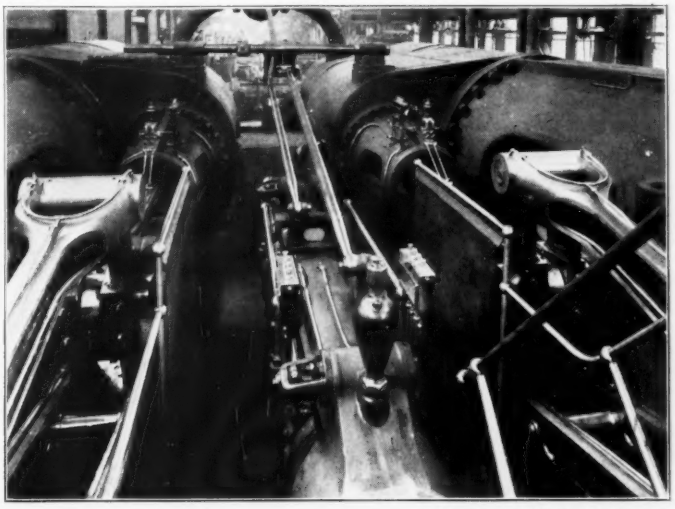
While it is usually possible to call in such a specialist from any reputable manufacturer of lubricants, certain industrial concerns will prefer to retain their own talent in this regard, or enlist the advice of a consultant.

Duties of the Plant Lubricating Engineer

As a general rule the plant lubricating engineer is a decided asset wherever a considerable volume of machinery is involved, and where impaired lubrication in any unit might seriously disrupt a production schedule.

In such concerns the plant lubricating engineer should have direct supervision of the storage facilities and the means of application of all lubricants. He should prepare oiling schedules, dictate periods for flushing and cleaning of lubricating systems, instruct operators as to the advantages to be derived from careful lubrication of their machinery, and co-operate with the chief engineer and master mechanic in the installation of new equipment or maintenance of existing units, wherever the matter of friction reduction may be involved.

An added advantage is that such an authority as a member of plant personnel can check up on the specifications of any lubricant which may be offered to the purchasing department, or he can prepare his own based on test data which he has developed according to the operating conditions involved. In many cases this will be positive assurance that the right kind of lubricants will be obtained and that effective lubrication and maximum reduction of friction will be accomplished.



Courtesy of Mesta Machine Co.

Fig. 11—The lubricating system for the external bearings of a reversing mill engine will frequently be extensive in layout. Positive flow of lubricants is the essential requirement on such equipment.

Lubricating Engineering Service

In many plants, however, the volume or nature of the machinery involved will not warrant the employment of such a specialist, or perhaps whoever this work may be detailed to will not have the requisite education or experience in matters of mechanical engineering and lubrication.

For such concerns lubricating engineering service as offered by the manufacturer of lubricants will be a decided asset.

Of course, it is absolutely essential that such service be backed by a reputable company. To seek advice from any who have not due regard for the title of "Lubricating Engineer" might be frequently hazardous in that there would be no assurance that their lubrication recommendations could be depended upon.

Lubrication engineering service of repute, however, is one of the greatest assets available to the operator of mechanical equipment. It affords an especially economical way of availing oneself of expert technical advice in regard

to solution of problems of lubrication and the determination of lubricants capable of maintaining operation in the most efficient manner.

Furthermore, the lubricating engineer who represents a reputable manufacturer of lubricants will as a rule be far more conversant with the many variables that must be considered, than he who is in the employ of any specific industrial concern. This is quite natural, for the latter has far less opportunity to study and familiarize himself with lubrication as applied to industry as a whole.

The oil company engineer, on the other hand, is in daily intimate contact with this phase of operation and production. He can approach the steel mill executive and quote experience with high temperature lubrication problems in the cement plant, for example, quite as readily as he can discuss the matter of low carbon content to the Diesel engine operator, and cite its advantages as developed for air compressor service.

In other words, he is so broadly trained by actual experience that his advice should never be overlooked. He can show the dollars to be saved in year-round power consumption and machine maintenance costs, where otherwise the pennies in cost per gallon of lubricating oils might be the sole consideration of the purchase.

Automotive Engine Lubrication In Cold Weather

WITH the approach of cold weather that ever-prevalent problem of adequate protection of the automotive engine by effective lubrication will once again confront many a motorist. He who operates the later model car may be severely perplexed.

On the one hand he has a variety of oil purifiers to judge. And the assurance that by their usage, the life of his motor oil will be markedly extended. This, of course, implies less frequent crankcase draining. It should be more economical.

But on the other hand there will be the increased possibility of dilution. This should dictate more frequent changing, just as the petroleum industry has always advocated.

It is not proposed to dwell upon the respective merits or advantages of the motor oil filter or purifier. Nor the optimistic statements of some engine builders, however justified these may be under conditions of normal operation.

Instead, this article will deal with the abnormal, for cold weather lubrication of the automotive engine may rightfully be regarded as of this nature, especially in our northern climates.

There are certain factors which will affect engine lubrication under such conditions, which the average oil purification device cannot overcome. They must, therefore, be understood, for they influence the original selection of motor oils for cold weather service, and the frequency of changing.

As a general rule, a motor oil, to be suited to cold weather operation, must:

A—Flow at zero or below.

B—Develop a minimum of carbon residue.

C—Show no tendency to gum, and

D—Have adequate operating viscosity to withstand dilution.

Selection of Motor Oils

In the selection of motor oils to meet these requirements it must be remembered that the efficiency of any automotive engine from a lubricating viewpoint will be largely dependent upon the operating temperature, and viscosity of the motor oil used.

Viscosity is essentially a function of the temperature. Hence it is evident that under colder atmospheric conditions the viscosity of a lubricant will increase, resulting in a lower degree of fluidity and involving greater internal or fluid friction.

Naturally, this will cause a reduction in lubricating efficiency and necessitate a greater consumption of power to bring the car up to, and maintain it at the desired speeds.

If the normal viscosity of the oil at 100° F. is comparatively high it is perfectly clear that under exceedingly low temperatures this oil might become so sluggish as to be relatively difficult to pump. It is for this reason that lighter, lower viscosity motor oils are used in the winter than in the summer.

Importance of Low Pour Test

In the refining of motor oils, it is possible to vary the pour test or temperature of congealment to some extent. Naturally, the lower this temperature, or in other words, the lower the pour test, the more suitable and dependable will the oil be for cold weather operation, other factors being equal. In view of this, the motor-

ist should endeavor to obtain as low a pour test oil as possible for winter usage.

Viscosity Also a Factor

In general winter operation, the viscosity of the motor oil should be reduced so as to give approximately the same lubricating efficiency as in warm weather. For example, were a heavy oil recommended for summer service in a particular engine, the use of a medium viscosity oil in the winter would generally be proper.

It can be appreciated that too viscous a lubricant might give rise to difficulty in starting, or be the cause of all manner of engine troubles, such as burned bearings, scored cylinders, or seizing of certain parts due to its being too viscous to be properly transmitted throughout the lubricating system.

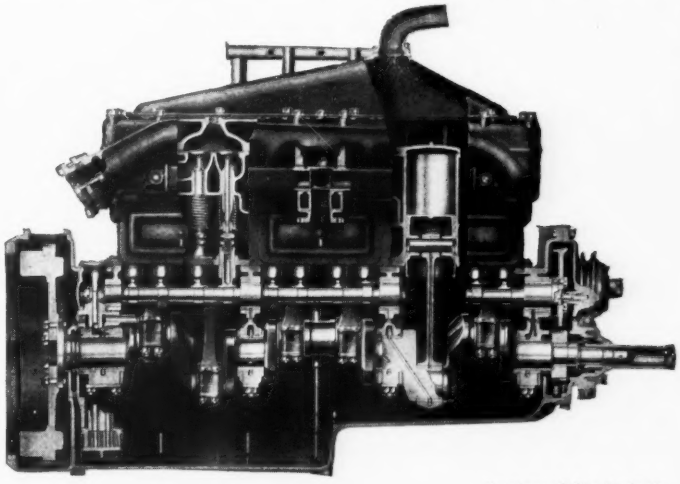
In other words, any inability of the pump to lift this abnormally heavy oil, or any possibility of it being discharged back into the crankcase through the relief valve, may result in the engine operating for perhaps several minutes with practically no lubrication.

Crankcase Dilution

Nor can crankcase dilution be relied upon as a uniform means of reducing oil viscosity. Too many variables are involved. In the average running of an automotive engine, crankcase dilution, or the reduction of the viscosity of the lubricating oil by unburned fuel occurs at practically all times. It may be especially rapid in cold weather. Normally, however, it will go only so far, apparently reaching an equilibrium point after a sufficient length of time, notwithstanding the entry of a certain amount of the lighter diluents whenever the choke is used or priming resorted to.

On the other hand, if dilution for any reason, as by excessive use of the choke, becomes abnormal and the diluent is by far the major part of the lubricating mixture, a condition may arise, as for instance in the sudden application of the load, wherein the lighter or diluent portions will be rapidly evaporated from the film on the cylinder walls because of rapid heating of the cylinders. In such a case, the lubricating film may be reduced sufficiently in thickness so that scored cylinders may be a possibility.

Experiments have shown that while the state of equilibrium between the lubricating oil and the lighter fuel portions will vary with the nature of the constituents, it will balance itself of its own accord if sufficient time is allowed. That is, if an equilibrium condition of 20 per cent diluent was normal for the case in question, if 40 per cent diluent were started with in the crankcase, the lubricating mixture would tend to return to its state of equilibrium.



Courtesy of The Buda Co.

Fig. 12—Sectional view of an automotive engine adapted for circulating pressure lubrication. The necessity for adequate fluidity can be appreciated, for such carefully designed equipment must be protected against wear at all times. Motor oils must never congeal or tend to become sluggish in cold weather.

Carbon Formation

In connection with this matter of dilution, it is decidedly necessary to keep in mind the relation which it bears to excessive carbon formation, or the building up of so-called carbon deposits, not only on spark plugs, pistons, cylinder heads, around the rings, and on the valves and seats, but also in the crankcase or oil sump itself.

Carbon in an engine combustion chamber, on valves, piston heads, spark plugs or in ring grooves, etc., is a detriment from the viewpoint of ultimate power developed. In bearing clearance spaces, however, it may in addition result in mechanical failures due to an impairment of circulation of the lubricant by the clogging of grooves or oil ducts. It must, therefore, be guarded against with the utmost care.

While carbon formation is more generally attributed to incomplete combustion of the fuel, to the use of excess lubricating oil, or to the entry of silicious foreign matter, such as road dust via the air intake or breather pipe, we must not lose sight of the fact that dilution is also a pertinent contributor.

It is perfectly evident that the lighter the lubricant, or the thinner the film on the cylinder walls, the more readily will it succumb to the possibility of pumping or being forced up into the combustion chamber, to be ultimately burned. The direct result may be the development of more or less carbon.

The amount of this latter will, of course, depend upon the residual carbon content of the oil. Where the latter burns cleanly the extent of such deposits will be relatively small. Furthermore, if the oil is properly refined and adapted to the purpose, such carbonaceous matter will be soft in appearance, low in quantity and comparatively easy of removal.

Over extended periods of operation, however, carbon deposits, whatever their nature, will be bound to increase. Furthermore, where pumping or forcing of a certain amount of lubricating oil into the combustion chamber occurs, the ultimate oil consumption will be higher, with a reduction in the mileage developed per gallon. In addition, dilution may involve the possibility of a certain amount of loss of compression due to impairment of the piston seal when the viscosity of the oil is so reduced that the lubricating film is comparatively readily wiped off by the piston rings.

Crankcase Draining

So it is justifiable to maintain that inasmuch as motor oils may be more easily reduced in lubricating ability in cold weather, more frequent changing should be practiced irrespective of engine construction or accessory equipment for the purpose of purification during operation.

The normal and safe recommendation is to drain and flush the crankcase and renew the motor oil every 400 to 500 miles. Oil is certainly cheaper than engine parts, and changing oil involves less time in the shop than does renewal of bearings, etc. But best of all, the operator can place the utmost dependence on his engine. Assuredly this warrants every attention to its lubrication.

Procedure When Flushing

When oil is changed it is usually good practice to wash the crankcase with a quart or two of warm light motor or flushing oil after draining, to remove sediment deposits from corners and other crevices.

The use of kerosene as an engine wash is inadvisable due to the possibility of an excessive amount of it remaining in the crankcase. Very frequently the crankcase drain plugs are not located so that all the flushing oil can be readily and completely drained. With such engines it is generally advisable to use a light lubricating oil for flushing, even though the expense may be slightly greater.

Turn the engine a few times by hand or with the self-starter, after adding flushing oil; never run it by its own power. Then drain off the latter, replace plug and add fresh motor oil.

Used motor oil, if not too dirty, can be employed for certain chassis lubrication, or to thin out the transmission or differential lubricant.

It will always be advisable to drain the crankcase of used oil while the engine is hot, inasmuch as considerable of the sediment and other accumulations of foreign matter will be more completely washed out.

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